Quarterly Report
July-September 1992

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I. Near-term Objectives

Refine and extend the data analysis algorithm developed by Nakajima and King for determining the cloud optical thickness and effective radius of clouds from reflected solar ratiation measurements. This program has thus far been applied to 2 channels of the MAS (MODIS Airborne Simulator), but will in the future be extended to multiple wavelengths appropriate for MODIS. Work has recently been completed on extending and porting this analysis program to the Cray-YMP computer, making use of its NetCDF libraries, and is currently undergoing work to increase its ability of analyzing data obtained from CAR (Cloud Absorption Radiometer) and other satellite sensors (NOAA AVHRR, Landsat, SPOT, etc.), in addition to MCR (Multispectral Cloud Radiometer) and MAS data.

II. Task Progress

a. MODIS-related Instrumental Research

The in-field calibration for MAS at Lajes, Azores, Portugal during the ASTEX (Atlantic Stratocumulus Transition Experiment, June 1992) field experiment has been processed and will be compared with the pre- and post-flight calibrations from Ames when they become available. However, it is not anticipated that the correction will be large, if any.

Preliminary results of post-flight calibration for CAR at Goddard, after the LEADEX (Lead Experiment, conducted in the Beaufort Sea, Alaska during April 1992) and the ASTEX field experiments, showed meaningful data for channels 1 to 7 and no data for channels 8 to 13 (filter wheel channels). The signal from the filter wheel channels was very noisy during both LEADEX and ASTEX experiments as well as during field calibration at Lajes when the InSb detector was not cooled by the liquid nitrogen properly. Correction to the measurements of LEADEX and ASTEX will be done solely based on calibrations of channels 1 to 7, and the pre-flight calibration of channels 8-13.

The CAR is presently undergoing a major upgrade. Michael King decided to replace the old high pressure nitrogen Joule-Thomsen InSb detector and cooling system of the filter wheel channels with a new Sterling-cycle cryogenic cooler and InSb detector assembly, both to improve their sensitivity and reliability and to reduce the requirement to have a source of high pressure nitrogen gas available at remote field experiment locations. Following this upgrade, the CAR will be operating in two different

configurations: the ultraviolet and cloud absorption mode. The main difference is that the usual non-absorbing channel (0.754 um) in cloud absorption mode will be replaced by a new uv-B channel (0.30 um) in the ultraviolet mode. This will enable us to measure the radiation available for photochemical reactions and new particle production in the upper layers of clouds.

b. MODIS-related Data Processing and Algorithm Study

Michael King and Si-Chee Tsay have documented the mission flight logs (ER-2 and C-131A respectively) for the ASTEX and LEADEX and prioritized the research flights for data analysis. The mission flight logs of ER-2 FIRE Cirrus IFO (Nov. - Dec. 1991) have also been documented by Michael King. Missions on 14 November 1991 of FIRE and 17 June 1992 of ASTEX were first selected to process and Liam Gumley has made the MAS Level-1B (i.e., calibrated and geolocated data) in the Network Common Data Format (NetCDF). In addition, the MAS quicklook images for these flights are available (one visible and one infrared channel). The images are sampled every 4th line and every 4th pixel.

Si-Chee Tsay has completed the setup of running the NetCDF formatted data on the Cray-YMP for the first time. An interesting case (cloud microphysics and radiation interaction) on June 17 (flight line 14) during ASTEX has been run to retrieve the effective radius and optical thickness of these clouds. Images of these results were created using Spyglass TRANSFORM by Tom Arnold. Frequency histograms of the retrieved optical thickness and effective radius were created by using Kaleidagraph to demonstrate the statistical properties of these clouds formed by two different types of air masses. These results have been presented in Japan by Michael King and in Colorado State University by Si-Chee Tsay.

Tom Arnold and Ward Meyer have processed the navigation (ground track) and microphysical data from C-131A flights for LEADEX and ASTEX through programs REFORMAT and NAVIGATE. Also, some modifications to these programs have been completed to enable them to process the ER-2 navigation data and handle additional C-131A microphysics parameters. The remaining microphysics files for Kuwait Oil Fire experiment (May 1991) were received and completed the first level of production runs.

Ward Meyer has modified CARANLYS to be compatible with new manual gain structure and reorganized input files for CARANLYS to reflect the changes of the filter wavelengths in the CAR. Active scan tape files for the LEADEX flights were produced through program CARASCAN and are ready for scientific analysis such as the surface (snow and sea ice) and cloud top bidirectional reflectance.

Si-Chee Tsay continued to work on radiation and microphysics models to simulate the scattered radiation field observed from the Kuwait Oil Fire smoke obtained from the CAR. The microphysics data of these smokes were re-composed from two aerosol instruments, which have different dynamical ranges, to compute the optical

properties of the smokes. The results of the simulated radiance field will be compared with measurements from CAR. Forward simulations of the multiple scattered radiation field at 0.63 and 0.82 microns were first conducted for water and ice clouds at different values of the effective radius to investigate the accuracy and efficiency of the model.

c. MODIS-related Services

Michael King attended the IWG meeting in Keystone, Colorado, where considerable discussion focussed on further descoping of the EOS mission. In the Atmosphere Panel meeting it was learned that there is a proposal from Bruce Barkstrom to conduct a Topical Science Workshop on Cloud Retrieval algorithms. This workshop should be a useful opportunity to further explore our cloud retrieval development effort with those of other MODIS, CERES, AIRS and MISR team members.

Michael King gave a presentation on MODIS at the ASPRS Annual Convention in Washington, DC. He also spent considerable time working on responding to suggested instrument and data product descopes suggested for MODIS as part of the Administrator-directed red and blue team evaluation of ways to reduce the EOS Project runout budget by 30% through FY2000. In addition to chairing the MODIS Technical Team meetings twice during the month, Michael King also began working with Jeff Dozier and the EOS Project Science Office on aspects of his new position as EOS Senior Project Scientist.

Michael King was invited to give a seminar at the Center for Climate System Research (CCSR) at the University of Tokyo on the "Radiative and Microphysical Properties of Clouds Modified by Pollution from Ships," as well as give an invited paper at the International WCRP Symposium, entitled "Radiative and microphysical properties of marine stratocumulus clouds." The WCRP Symposium consisted of 8 sessions over a six day period, and included sessions on TOGA (Tropical Ocean and Global Atmosphere Programme), Cloud-radiation processes, Cloud distribution, and the Microstructure and radiative properties of both water and ice clouds. This was the first scientific meeting in which MAS-analyzed optical thickness and particle radius retrievals were presented. There was much interest in this invited paper, MAS retrievals, ship tracks and their influence on climate, and the EOS Program in general.

III. Anticipated Activities During the Next Quarter

a. attend the MODIS Preliminary Design Review and MODIS Science Team meeting in Santa Barbara (October 21-29) and the FIRE Science Team meeting in Fairfax (November 9-13) to present results from LEADEX and ASTEX experiments;

b. continue the effort of refining the data analysis algorithm and of increasing its ability to analyze data obtained from instruments other than MCR and MAS;

c. continue to analyze the bidirectional reflectance measurements obtained during the LEADEX and ASTEX experiments;

d. continue to simulate the Kuwait Oil Fire case study of the bidirectional reflectance pattern of the oil fire smoke to assess our ability to model and understand the spectral and angular reflectance pattern observed from the smoke which contained oil drizzle droplets;

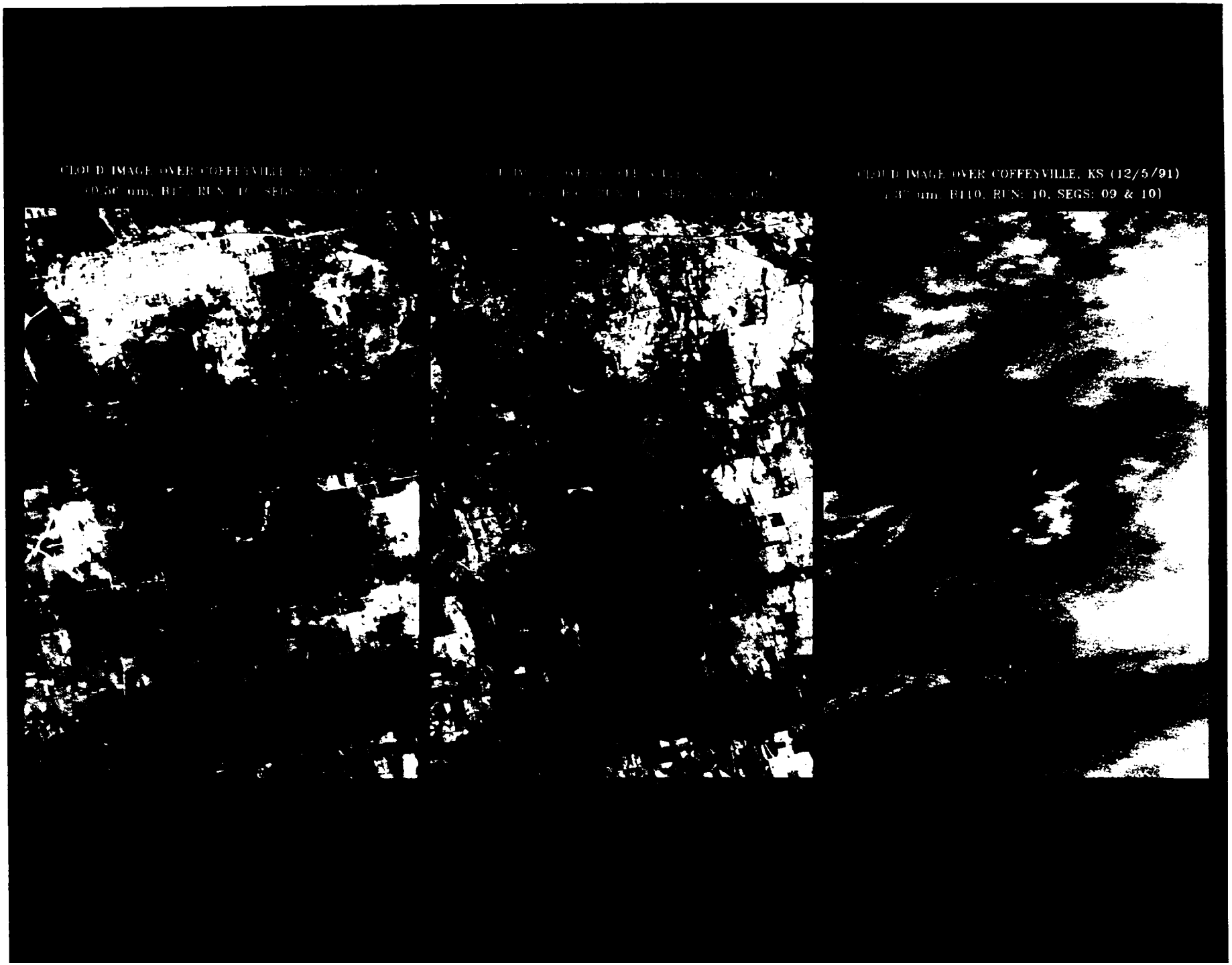
e. re-examine more carefully the retrieval of cloud optical and microphysical properties by using data gathered from MAS.

IV. Problems/Corrective Actions

No problems that we are aware of at this time.

V. Publications

King, M. D., 1992: Directional and spectral reflectance of the Kuwait oil fire smoke. J. Geophys. Res., 97, 14545-14549.


CLOUD IMAGE OVER COFFEYVILLE, KS (12/5/91)
0.56 um, B110, RUN: 10, SEGS: 09 & 10)
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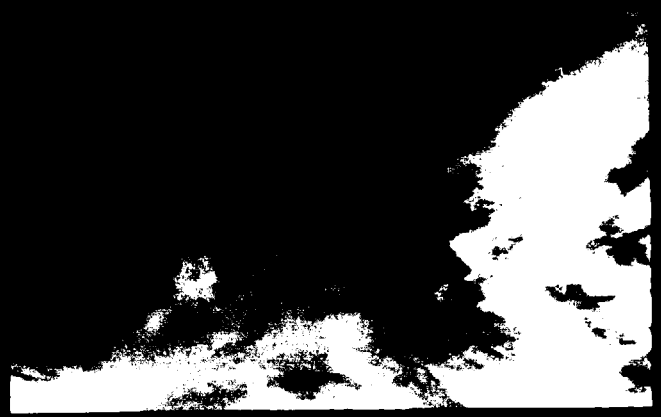
CLOUD IMAGE OVER GULF OF MEXICO (12/5/91)
(0.56 um, B17, RUN: 03, SEG: 04)

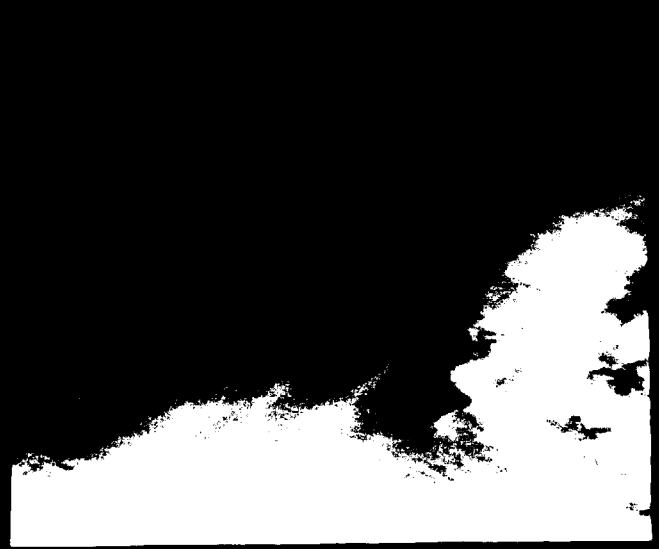
(CSES/U. OF COLORADO)

CLOUD IMAGE OVER GULF OF MEXICO (12/5/91)
(1.35 um, B108, RUN: 03, SEG: 04)



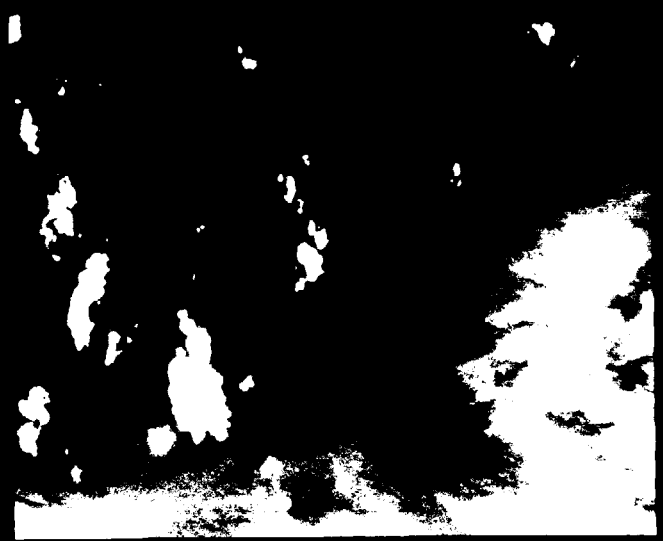
(CSES/U. OF COLORADO)

CLOUD IMAGE OVER GULF OF MEXICO (12/5/91)
(1.38 um, B111, RUN: 03, SEG: 04)



(CSES/U. OF COLORADO)

CLOUD IMAGE OVER GULF OF MEXICO (12/5/91)
(1.50 um, B123, RUN: 03, SEG: 04)



(CSES/U. OF COLORADO)

CONCLUSIONS - RECOMMENDATIONS

- The 1.38 μm ($\Delta\lambda$=50 nm) can sense thin cirrus clouds undetectable otherwise during the day.

- Very good separation between cirrus clouds and clouds under 6 km due to the strong water vapor absorption in the lower atmosphere.

- Recommend to replace the current MODIS Channel 23 (4.050 μm) with the 1.38 μm ($\Delta\lambda$=50 nm).

- M. King and P. Menzel already agreed with this recommendation.

- Need to check the technical aspects of this modification.